**Culminating Task**

**SBI3UAnimals: Structure and Function**

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**Determining Fitness Level: Teacher’s Notes**

**Description of activity:**

In pairs or small groups, students will design a fitness test and then carry it out to investigate the relationship between physical activity and the production of CO2. They will use this information to determine the amount of oxygen being delivered by the respiratory and circulatory systems to the body’s tissues.

**Timeline:**

This activity should be assigned at the end of the Internal Systems and Regulation unit in which the students learn about the circulatory, respiratory, and digestive systems. The activity will require a couple of weeks to complete, with some of the work being done at school and some of it on the student’s own time.

**Background knowledge needed:**

* Students need to know:
  + the structures and functions of all three systems
  + that blood carries nutrients and oxygen to the tissues and waste away
  + the difference between the pulmonary circulatory system and the systemic circulatory system
  + the meaning of the terms heart rate, cardiac output, and stroke volume and the normal values for each
  + the meaning of the terms tidal volume, vital capacity, expiratory reserve volume, inspiratory reserve volume and the normal values for each
  + how to use a respirometer

**Planning and Prep:**

For this assignment students will be required to use repirometers. Some schools have commercial respirometers which are preferred since they are easier to use and provide more accurate results. However, respirometers can be made relatively easily. To make a respirometer you need a water plastic water bottle half filled with water, bromothymol blue is added to the water (it should turn blue or greenish blue), a long tube is placed into the water so that the other end of the tube sticks out the top. Seal the top, around the tube, using putty or plasticine. Stick another, smaller tube through the seal to allow excess air to escape. Since CO2 is highly soluble in water, when a person breathes into the long tube the CO2 dissolves in the water and makes it more acidic therefore changing the pH and changing the colour of the indicator. Students would also have to be given a reference sheet, if they are to use the homemade respirometer so that they can compare the colour of their solution to determine the amount of CO2 exhaled.

Though not necessary, it may be helpful to book time in the gym for your class in order for them to carry out their fitness test. It could be booked for one week after the activity is assigned so that the students have one week to design their test. They could then be given another week to complete the analysis.

**Safety:**

There are a number of safety concerns with this lab so it is important that safety is

discussed with the class before the start of this activity.

* The first safety concern is the use of exercise equipment. If students are going to use any equipment to carry out their fitness test it must be used the manner it was designed to be.
* Students have to ensure that the person doing the test is safe. No one with asthma should do be the subject since doing physical activity then being forced to breath into a tube would be difficult. The test should stop immediately if the subject feels dizzy or is having hard time breathing.
* If using the homemade respirometer, the subject has to be reminded not to suck in any of the liquid; the tube is only used during expiration not inspiration.

**Differentiated Assessment options:**

While all of the students are doing the same activity, the final product can be differentiated.

Some possible ideas for the final product could include:

* a formal written lab report (no presentation to the class)
* a poster board presentation (no presentation to the class)
* a PowerPoint presentation (with a presentation to the class)
* as a TV interview (no presentation to the class)

**Determining Fitness Level: Student Handout**

Since the Amateur Athletics Federation began keeping records, there has been a steady increase in the performance level of elite athletes. Today, Olympic athletes run faster, jump higher, and throw farther than ever before Since the turn of the century, records for power events have greatly improved, such as the 100-m sprint which improved by 10% and the long jump which improved by 20%. In the endurance events, previous records have been surpassed by an even greater margin. At the 1908 Olympics in London, the winning time for the marathon was 2:55:18. In 1999, Khalid Khannouchi covered that same distance in 2:05:42, almost 30% faster. Better nutrition and improvements in technology and training help to explain the progress.

Despite improvement in the performances of elite athletes over the past century, the fitness level of the general public has declined. A sedentary lifestyle and changing eating habits are factors in the increased mass of the average person. It has been estimated that one out of every three meals for most North Americans is consumed at a fast food outlet, where meals are high in fat content.

The ability to exercise depends upon your ability to deliver oxygen and nutrients to the muscles and brain. Oxygen demand increases as activity becomes more vigorous. An Olympic cross-country skier and an out-of-shape “couch potato” with the same size body have the same oxygen demands while resting or running. The skier’s superior performance during exercise is due to the fact that she delivers more oxygen to her cells during vigorous exercise; her cardiac output and respiratory system make more oxygen available to the cells.

**Investigation**

For this task, you and a partner will design and carry out a fitness test that indicates, by indirect means, the amount of oxygen being delivered to the tissues. You will not actually be measuring the amount of oxygen delivered. However, your ability to perform certain physical tasks and the speed at which they can be done are indicators of the amount of oxygen being delivered by the respiratory and circulatory systems and if the amount used by the muscles.

To design a fitness test, you need to consider a number of factors including the following:

* The indicators you will use to determine fitness level
* The equipment you will use (diagnostic and exercise)
* The availability of equipment (at school, at home, at a fitness centre)
* Safety precautions (regarding subject’s physical health and use of equipment)
* The number of subjects who will be tested

Present your design to your teacher for approval before beginning your fitness testing. After your design has been approved, carry out the test.

Once your investigation is completed, write a detailed report to communicate the Procedure, Observations, and Analysis of your investigation. Use appropriate scientific vocabulary, tables, and correct significant figures and SI units where appropriate.

**Question**

How can you determine the fitness level or oxygen uptake of an individual during exercise?

**Materials/Equipment**

Respirometer (commercial or homemade model)

Complete the list of materials and equipment (diagnostic and exercise) required.

**Procedure**

1. Describe in detail each component of the test.
2. Be sure to provide instructions on the use of all equipment.
3. Include safety precautions where appropriate.

**Observations**

* Include base-line measurements of lung volumes, pulse rate, and other appropriate data.
* Display your data in a table, chart, and graph.

**Analysis**

1. Determine the fitness level of the test subject. Provide the formula(s) necessary to determine this value and be sure to use the correct SI units for the measurements involved. Include the measurement of uncertainty, as a percentage, if appropriate.
2. You may want to compare your results against a chart of standards, either standards determined by you and your group or from a source on the internet.

**Evaluation**

1. Were there difficulties in obtaining the data? If so, suggest ways to improve the design.
2. Evaluate the chart of standards. What are the limitations of using these standards to evaluate a person’s fitness?

**Synthesis**

1. Often people associate slimness with being physically fit. Provide arguments to the contrary.
2. People who diet are often advised to incorporate exercise into their daily routine. Describe the relationship between diet and exercise in terms of the improvements in cardiovascular fitness and metabolism. Provide a case study example.
3. Describe how you might customize your fitness test for specific sports (e.g. hockey, football, golf) or for specific positions (e.g. goalie, quarterback)

**Assessment**

Your completed task will be assessed according to the following criteria:

*Process:*

* Develop a design for the study
* Choose and safely use appropriate tools and equipment
* Record observations with appropriate precision
* Analyze the results
* Evaluate the design
* Identify possible sources of error

*Product:*

* Prepare a suitable lab report, including a fitness profile of the test subject.
* Justify your conclusions
* Demonstrate an understanding of pertinent concepts.

**Assessment Rubric:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Achievement Chart Category | Level 1 | Level 2 | Level 3 | Level 4 |
| Knowledge and Understanding | In developing fitness test, describes scientific and technical principles related to the test with limited detail  Used appropriate tools and equipment for design, showing a limited understanding of relevant scientific concepts. | In developing fitness test, describes scientific and technical principles related to the test with some detail  Used appropriate tools and equipment for design, showing some understanding of relevant scientific concepts. | In developing fitness test, describes scientific and technical principles related to the test with considerable detail  Used appropriate tools and equipment for design, showing considerable understanding of relevant scientific concepts. | In developing fitness test, describes scientific and technical principles related to the test with thorough detail  Used appropriate tools and equipment for design, showing thorough understanding of relevant scientific concepts. |
| Communication | Organizes lab report with limited effectiveness  Using limited scientific vocabulary each component of the test was described using limited detail.  Instructions and safety precautions were outlined with limited effectiveness. | Organizes lab report with some effectiveness  Using some scientific vocabulary each component of the test was described using some detail.  Instructions and safety precautions were outlined with some effectiveness. | Organizes lab report with a considerable effectiveness  Using considerable scientific vocabulary each component of the test was described using considerable detail.  Instructions and safety precautions were outlined with considerable effectiveness | Organizes lab report with a high degree of effectiveness  Using a variety of scientific vocabulary each component of the test was described using thorough detail.  Instructions and safety precautions were outlined with a thorough level of effectiveness |
| Application | Test design demonstrates limited creativity and originality  Implements newly designed test and provides data on a subjects’ fitness level with limited accuracy and effectiveness.  Identifies test design shortcomings with limited accuracy.  Provides a limited number of valid suggestions for test improvement. | Test design demonstrates some creativity and originality  Implements newly designed test and provides data on a subjects’ fitness level with some accuracy and effectiveness.  Identifies test design shortcomings with some accuracy  Provides some valid suggestions for test improvement. | Test design demonstrates adequate creativity and originality  Implements newly designed test and provides data on a subjects’ fitness level with a considerable level of accuracy and effectiveness.  Identifies test design shortcomings with considerable accuracy  Provides a considerable number of valid suggestions for test improvement. | Test design demonstrates an outstanding level of creativity and originality  Implements newly designed test and provides data on a subjects’ fitness level with a very high level of accuracy and effectiveness.  Identifies test design shortcomings with a high degree of accuracy  Provides a considerable number of valid and varied suggestions for test improvement. |
| Thinking -Inquiry | Responds to proposed “synthesis questions’ by providing arguments that demonstrate a limited understanding of scientific concepts | Responds to proposed “synthesis questions’ by providing arguments that demonstrate some understanding of scientific concepts | Responds to proposed “synthesis questions’ by providing arguments that demonstrate a considerable understanding of scientific concepts | . Responds to proposed “synthesis questions’ by providing arguments that demonstrate a thorough understanding of scientific concepts |